ALFA PROGETTI S.r.l. - Spilamberto (MO) Tel. +39 059 785 726 - Fax +39 059 785 737
www.alfaprogetti.com

SmartON / SmartON+ Installation and Use Manual

Rev. document	Date document	Ver. SmartON	Ver. SmartViewII	Notes
1.0	06/04/2007	3.08	2.30	Pre-release
1.01	10/04/2007	3.08	2.30	Release
1.02	04/10/2007	3.09	2.31.05	Release
1.03	17/04/2008	3.09	2.31.05	Update
1.04	07/04/2010			Update and use

Index

Foreword **3**
1 – Package content **3**
2 – Operation **4**
2.1 – Working Cycle 4
2.2 – Anomalies 5
2.3 – LED Signals 5
2.4 – Estimation of the recharge 6
2.5 – Opportunity Charging 6
2.6 – Lock functions (SmartON+ only) 6
2.7 – Use of the button (SmartON+ only) 7
3 – Mounting **8**
3.1 – Preliminaries 8
3.2 – Wiring 9
3.3 – Final Steps 10
4 – Programming **11**
4.1 – Making it ready 11
4.2 – Setting of date / time 11
4.3 – Programming of operating parameters 11
4.4 – Programming of associations 14
5 – Alignment **15**
6 – Specifications **16**

Foreword

This installation manual refers both to Smart.ON and Smart.ON+ devices.
When Smart.ON is indicated, both devices are meant. If instructions refer to only one of the 2 devices, this will be specified.
To install Smart.ON+, battery connector has to be equipped with at least 2 auxiliary contacts.

1 – Package content

The package contains the following parts:

- The Smart.ON device of the size required equipped with wire terminals and conical fairleads
- 2 fairleads for cables with a reduced cross section area
- Protection adhesive for the bottom side

Package content (Smart.ON to the left, Smart.ON+ to the right)

2 – Operation

SmartON is a device designed for the monitoring and control of lead batteries. Its main features are:

- Measurement of the instantaneous battery data including voltage, current, available Ah and temperature. An indication of the amount of Ah available is provided by LEDs on the panel (§2.3 –)
- Built-in RTC (Real Time Clock) to build a log of the data collected with date and time
- Storage of historical data. The past activity of the battery can be accessed on a PC using the SmartViewII software application or through WEB. The data collected can be viewed grouped by working cycle or by day. For each working cycle the data is presented both in figures and graphics
- Data download to a PC. Through an IR connection all data can be sent to the SmartViewII PC program
- Statistical analysis. SmartViewII has numerous functions able to provide statistics to check the correct use of the battery and the charge reporting any anomaly.

2.1 – Working Cycle

A **working cycle** is intended as a sequence comprising a **discharge stage followed by charging stage**. Given that a change of cycle is forced in the case of a new association, power failure, or long period of inactivity after a charge, this definition should be understood as a guideline. Another exception of the definition occurs when the option “Opportunity Charging” is set (see §2.5 – Opportunity Charging).

The transition from discharge to charge occurs after 2 minutes of charging to avoid misinterpretations due to the presence of a charge recovery device during braking (in this case it is intended as energy recovery and the input charge will be added to the “Recovered Capacity”).

During the discharge stage the "Discharged Capacity" is counted. In addition, two situations which may arise in case of excessive discharge are highlighted: the "Underdischarge Time" which indicates the time when the voltage is below the "Underdischarge Voltage" configured (see §4.3 – Programming of operating parameters); and the "Discharged Capacity Under AhBS" indicates the capacity used below the threshold of (100-AhBS)% of the nominal battery capacity. During the discharge stage the "Self discharged Capacity" and the "Recovered Capacity" are also counted.

Within the charging stage there is a *First Stage* (the charge before reaching the configured "Voltage Threshold 2nd Stage"), the *Second Stage* (the charge following the attainment of the "Voltage Threshold 2nd Stage") and the "Capacity in Overcharging" (corresponding to any charge in excess over the hypothetical attainment of 109% of the nominal capacity). Only in the case of controlled Chargers (SmartEnergy) is the "Equalization" count displayed.

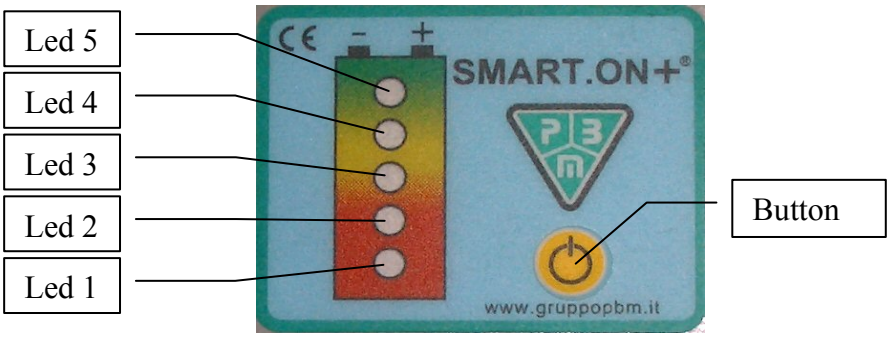
For a detailed list of the information provided by SmartViewII (Info TAB and OLD Data Info TAB) see the relevant manual.

2.2 – Anomalies

The SmartViewII program provides information about anomalies found in the cycle.

Anomalies	**Description**
Safety Timer 1st Stage	While charging the battery voltage did not reach the "Voltage Threshold 2nd Stage" by the "Safety Timer 1st Stage" (see §4.3 – Programming of operating parameters)
Safety Timer 2nd Stage	While charging during the 2nd Stage, the battery charge did not reach the nominal capacity by the "Voltage Threshold 2nd Stage" (see §4.3 – Programming of operating parameters)
Battery Discharged Under AhBS	While discharging, the battery capacity dropped below the "Battery discharged threshold (AhBS)" (see §4.3 – Programming of operating parameters)
Low Battery Efficiency	The battery has been in an underdischarging state for a time ≥ "Under-Discharge" time when the remaining battery capacity is ≥ (Battery Ah – Battery discharged threshold (AhBS)) (see §4.3 – Programming of operating parameters)
EEPROM/RTC Failure	A failure in the memory of the SmartIC device or RTC was detected

2.3 – LED Signals



The five LEDs on the unit provide useful information including an indication of the battery charge. LEDs can signal the following situations:

LED 1 flashing	Battery charge not exceeding (100-AhBS)% of the nominal battery capacity
LED 1 ON	Battery charge over (100-AhBS)% and below 40% of the battery capacity
LED 1 and 2 ON	Battery charge over 40% and below 60% of the battery capacity
LEDs 1-3 ON	Battery charge over 60% and below 80% of the battery capacity
LEDs 1-4 ON	Battery charge over 80% and below 95% of the battery capacity
LEDs 1-5 ON	Battery capacity over 95% of the battery capacity
Periodic shut OFF of the LEDs from top-down (sequence from LED 5 to LED 1)	Discharge Stage
Periodic turning ON of the LEDs from bottom-up (sequence from LED 1 to LED 5)	Charging Stage
LED 3 Flashing	Forks Lock due to the Anti opportunity charging activated, see §2.6 – Lock functions (SmartON+ only)
LED 4 Flashing	Forklift Lock activated (due to scheduling), see §2.6 – Lock functions (SmartON+ only)
LED 5 Flashing	Forks Lock activated (due to low battery charge), see §2.6 – Lock functions (SmartON+ only)

NOTE: AhBS is a programmable parameter through SmartView. If the value assigned is lower than 60%, the signalled events will differ from those reported in the table with regard to the first LED from the bottom that will flash with battery charge below (100-AhBS)%.

2.4 – Estimation of the recharge

Thanks to the features described above, SmartON+ is able to accurately estimate the charge in the battery.
There are two different ways to determine the attainment of a full charge. The first (traditional, by time) foresees that the battery is considered charged after the duration of the charge subsequent to the attainment of the "Threshold Voltage 2nd Stage" has reached the "Safety Timer 2nd Stage" (see §4.3 – Programming of operating parameters). The second way (Ah), in contrast, foresees that the charge is considered sufficient when the restored capacity added to that present at the time the battery charge is initiated equals the nominal capacity. The Default setting is the Ah method (see §4.3 – Programming of operating parameters).

NOTES:
- With the Ah method, through the SmartEnergy family battery charger, the battery is supplied only with the power strictly necessary to achieve the full charge, thus saving energy and avoiding damage and waste of water.
- Alignment (see §5 – Alignment) occurs only after a full recharge cycle is conducted.

2.5 – Opportunity Charging

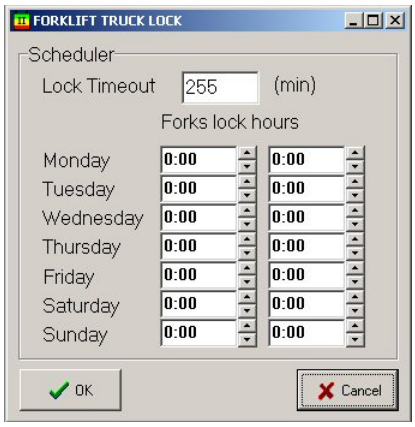
The term "Opportunity Charging" means the mode of use with which the battery is repeatedly charged and discharged for short periods and small capacity (as happens for example in the AGVs - Automatic Guided Vehicle). In this situation there would be a proliferation of working cycles that would lead to a rapid depletion of memory and substantially illegible data. In these cases, by setting the item "Opportunity Charging" in the programming (§4.3 – Programming of operating parameters), it is possible to reduce the daily number of cycles: in fact, in this mode a new cycle is generated only if there is a discharge after the sum of cycle charge times has already exceeded the time.

2.6 – Lock functions (SmartON+ only)

The Smart.ON PLUS device foresees two functions based on measurement of the battery capacity level to inhibit the operation of the forklift and/or lock the forks through the NO contact (Normally Open) of a relay.
These functions require that the relay contact is wired to a circuit of the forklift which can limit the functionalities (for example, the circuit that stops operation when the operator is not seated).
Anti opportunity Charging: After being charged, if the percentage of Ah in the battery is higher than that which is programmed in "Anti Opportunity Charging" (see §4.3 – Programming of operating parameters), the forklift is enabled for normal use (the NO contact is closed). Conversely, if the battery capacity drops below the programmed percentage, use is prevented (the NO contact remains open). Setting the parameter to 0% (as a default) the function is disabled.
Forks Lock: When discharging, until the battery level drops below the (100-Forks Lock)%, normal operation is permitted (the NO contact is closed). In contrast, when the capacity drops below this threshold, normal use is prevented (the NO contact is left open).
NOTE: To avoid disrupting manoeuvres during a period of intensive use, the lock is executed 30 seconds after the last manoeuvre.
The default value of the programmable parameter "Forks Lock" is 80%.

The Smart.ON PLUS device also foresees the following lock function:

Forklift Lock: For each day of the week it is possible to set the time (start and end) with which to impose a lock on the forklift. If the two times coincide, the lock does not occur. The "Lock Timeout" parameter indicates the forklift downtime that must elapse before the lock is operational.



2.7 – Use of the button (SmartON+ only)

- If during discharge the "Forks Lock" situation is reached, the pressure on the button ensures an additional bonus of usable capacity equal to 4% of the nominal capacity
- If, during a working cycle the different power points are blocked for "Anti opportunity Charging", pressing the button disables the lock for that cycle
- Within 6 minutes of providing the power supply, repeatedly pressing the button forces the amount of Ah present in the battery with an increase of 20% of the nominal capacity each time (note: it does not perform the alignment). This feature is useful if the "Forks Lock" function is selected to allow normal use of the fork lift after the installation of SmartON before the alignment charge is executed.

3 – Mounting

Smart.ON has to be mounted on the battery negative cable. This cable has to be cut so as to place the shunt inside the Smart.ON between the 2 cut ends.

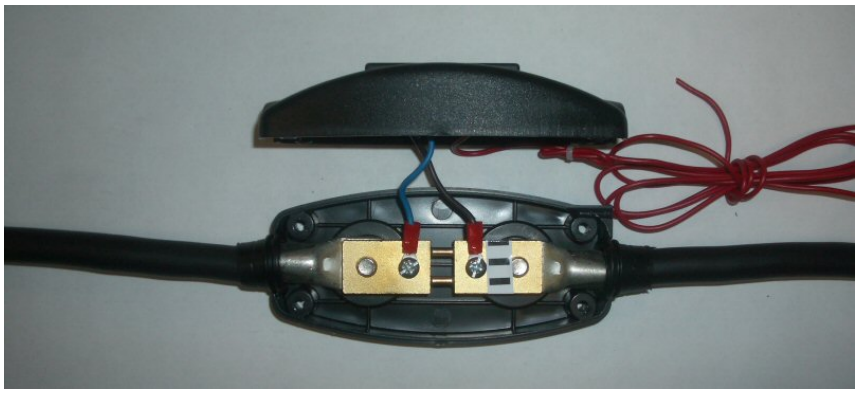
3.1 – Preliminaries

- Disconnect the negative cable from the battery negative pole and from connector, so as to work without taking any risks
- Unscrew the Smart.ON cover and remove conical fairleads and wire terminals
- If necessary, cut the conical fairleads in order to allow the cable with the desired cross section area to go through
- Select the wire terminals most suitable to the cable cross section area among the ones available
- Choose the position on the battery where you want to install Smart.ON, so as to determine the cable lengths between Smart.ON and negative pole and between Smart.ON and connector.

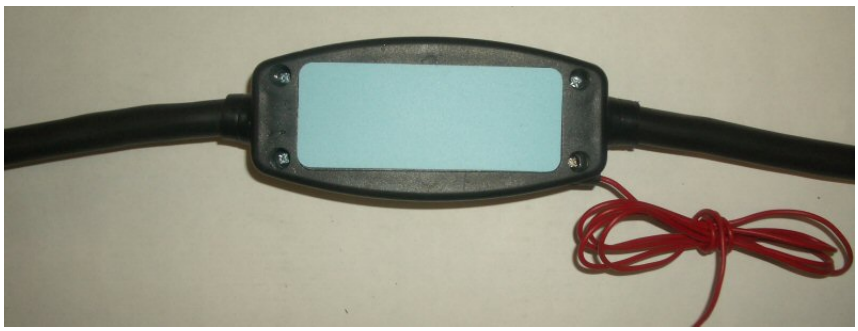
3.2 – Wiring

- Cut the battery negative cable so as to have Smart.ON in the previously fixed position.
- Insert the conical fairleads into the 2 cut cable crop ends and insert the wire terminals.
- Wire terminals have to be put between the plastics case and the shunt, in the same position as they were originally.
- Screw the cable with the terminal to the shunt. PLEASE NOTE: CONNECT THE BATTERY-SIDE END TO THE SHUNT NEGATIVE SIDE (shown by the adhesive).
- Stick the protection adhesive on its seat, on the bottom of Smart.ON.
- Close the cover of Smart.ON after placing the cable fairleads and the red wire in the right position. Fasten the cover with screws.
- Equip the terminal of the red cable coming out of Smart.ON with a wire terminal (not on issue) or any other system suitable for making a connection to the battery positive pole.
- **Only Smart.ON+:** cut the *Forks Lock* control cable, coming out of Smart.ON+, at a length which allows to reach battery connector. Insert the auxiliary contact pins (not on issue[1]) into the wires ends.

Connector side



Battery side

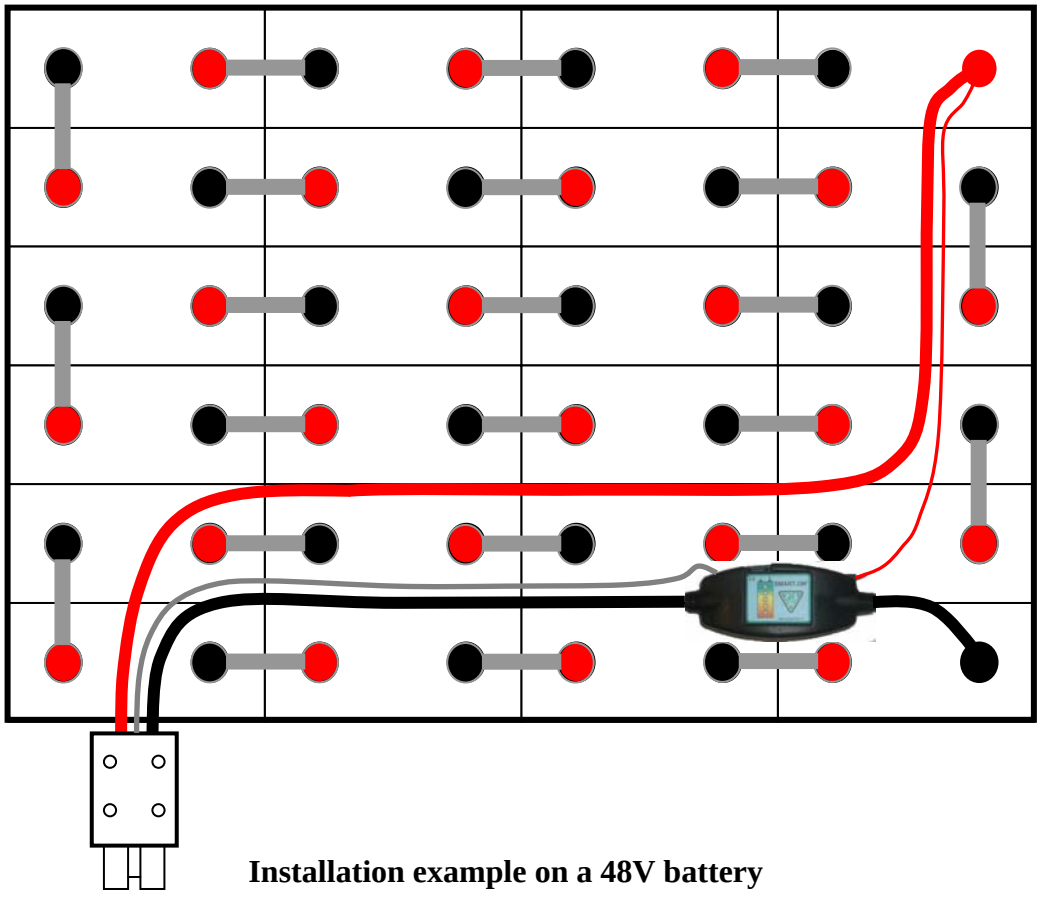


Wirings

[1] The auxiliary contacts on liftruck side shall be wired to interrupt the forks circuit or any other circuit which limits the functions of the forklift truck. Note: Smart.ON+ delivers a clean closed contact, if the function is enabled, an open contact in the case of lock.

3.3 – Final Steps

- Connect the previously removed pin to the battery connector.
- Connect the terminal of the previously removed wire again to the negative pole.
- **Only Smart.ON+:** plug the auxiliary contact pins, inserted into the wires ends, into the connector, and connect it to the battery negative cable.
- Connect the red wire of Smart.ON to battery positive pole, TAKING CARE TO PLACE AND FIX IT PROPERLY IN ORDER TO PREVENT IT FROM BEING ACCIDENTALLY CUT OFF.
- A few seconds after connection the red LED will blink showing battery presence on Smart.ON.



Installation example on a 48V battery

4 – Programming

Once installed, Smart.ON needs to get some information to work correctly.
For this purpose it is necessary to connect it to a PC equipped with the SmartViewII program for Windows. This can be done through an infrared port.

4.1 – Making it ready

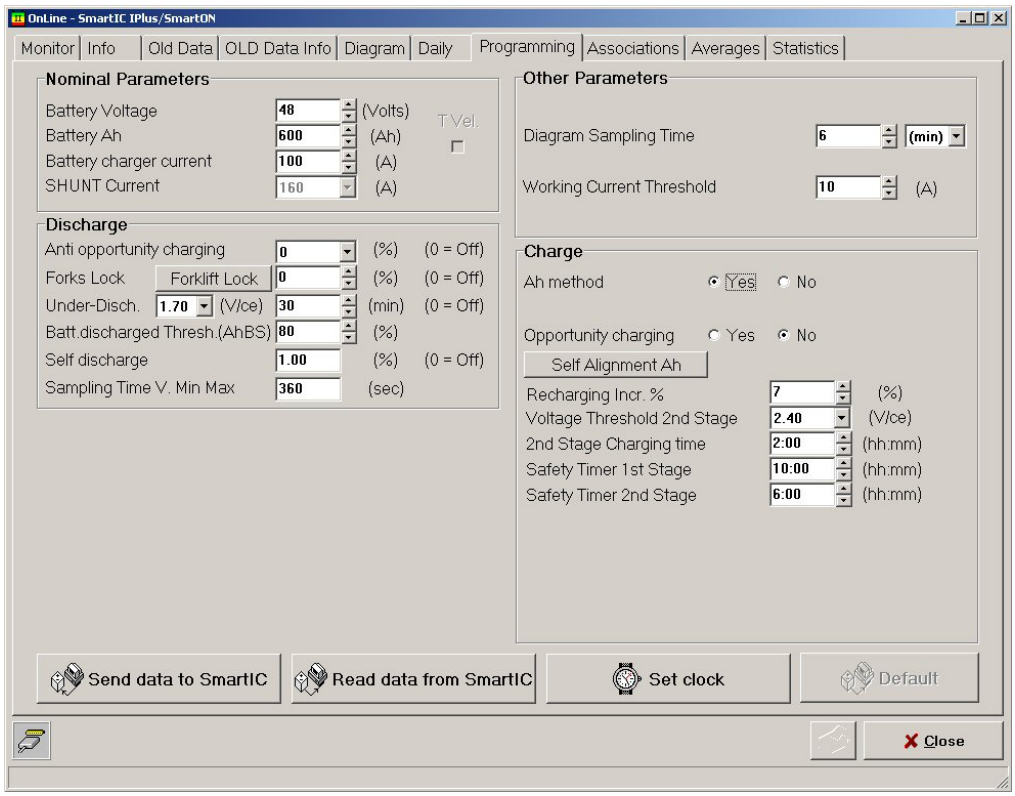
- Connect the infrared adapter to the PC (AP160 adapter to a RS232 port, or AP160UIR adapter to an USB[2] port)
- Trigger the SmartViewII program
- Insert the Password for level 2
- Press the "Connect" pushbutton

4.2 – Setting of date / time

- Select the "Programming" TAB
- Press the "Set clock"[3] push-button
- Select the "Monitor" TAB and check data in the box showing date and time

4.3 – Programming of operating parameters

The operating parameters allow Smart.ON to collect data correctly during the normal operation. Therefore they have to be compiled very carefully.
For more details, please see the user manual of the SmartViewII program.



SmartViewII: programming of the operating parameters

- Select the "Programming" TAB
- Fill in the following fields:

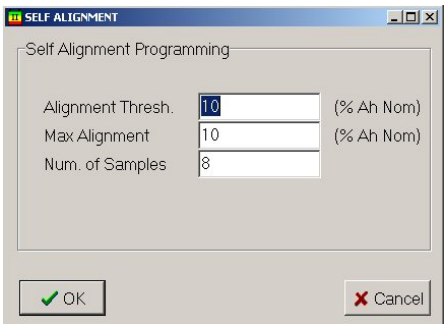
[2] The AP160UIR device needs to be previously installed through a driver for Windows
[3] The process transfers date and time on PC to Smart.ON: check that the PC dater is correctly set

Battery Voltage	Nominal voltage of the battery
Battery Ah	Nominal capacity of the battery
Battery charger current	Nominal current of the battery charger
Shunt Current	Nominal value of the Shunt
Diagram sampling time	Voltage and current log sampling times for graphs (1, .., 127 min / 1, .., 127 sec); (default: 6 min) NOTE: If expressed in seconds, the duration of cycles will be one hour at most
Working current threshold by contract	See manual SmartViewII (default: 10A)
Anti opportunity charging	**SmartON+ only:** Forks lock setting for anti opportunity charging. See §2.6 – Lock functions (SmartON+ only)
Forks Lock	**SmartON+ only:** Forks lock setting for low battery charge. See §2.6 – Lock functions (SmartON+ only)
Forklift Lock	**SmartON+ only:** Forklift Lock schedule setup button. See §2.6 – Lock functions (SmartON+ only)
Under-Discharge	If the voltage is below the specified value (V/el) for the specified time (minutes), the capacity is forced to (100-AhBS)% of the nominal capacity Ah Battery if greater than said value (default: 1.70 V/el, 30 minutes)
Battery discharged threshold (AhBS)	Discharging below (100-AhBS)% of the nominal capacity the battery is considered discharged (default 80%)
Self discharge	Self-discharged capacity every 24 hours (default: 1%)
Ah method	Charging mode selection: capacity (Yes) or time (No) (default: YES)
Opportunity charging	Selection of scheduled counting of working cycles (opportunity charging mode) (default: No)
Self Alignment Ah	Access button to set the Self alignment parameters
Recharging Incr. %	Percentage of energy dissipated during charging stage (default: 7%)
Voltage Threshold 2nd Stage	Gas production voltage threshold. Determines the transition from the first to the second charging stage and related counts (default: 2.40 V/el)
2nd Stage Charging time	Time after exceeding the Voltage Threshold 2nd Stage to end the charge for timed recharges and in the alignment cycle (default: 2:00 hours)
Safety timer 1st Stage	If the voltage has not reached the Voltage Threshold 2nd Stage within this time period, an alarm is generated (default: 10:00 hours)
Safety timer 2nd Stage	If the capacity has not reached the nominal value within this time period starting from the achievement of the Voltage Threshold 2nd Stage, an alarm is generated (default: 6:00 hours)

The Self alignment function automatically corrects the indication representing the charge available in the battery Ah. The configurable parameters indicate the threshold beyond which the correction is performed, the maximum possible alignment and the number of samples on which the "Self Alignment" is based. The "Self Alignment" is allowed only if the alignment has already been done (see §5 – Alignment).

Default parameters:

Alignment Threshold	10%
Max Alignment	10%
Num. Of Samples	8

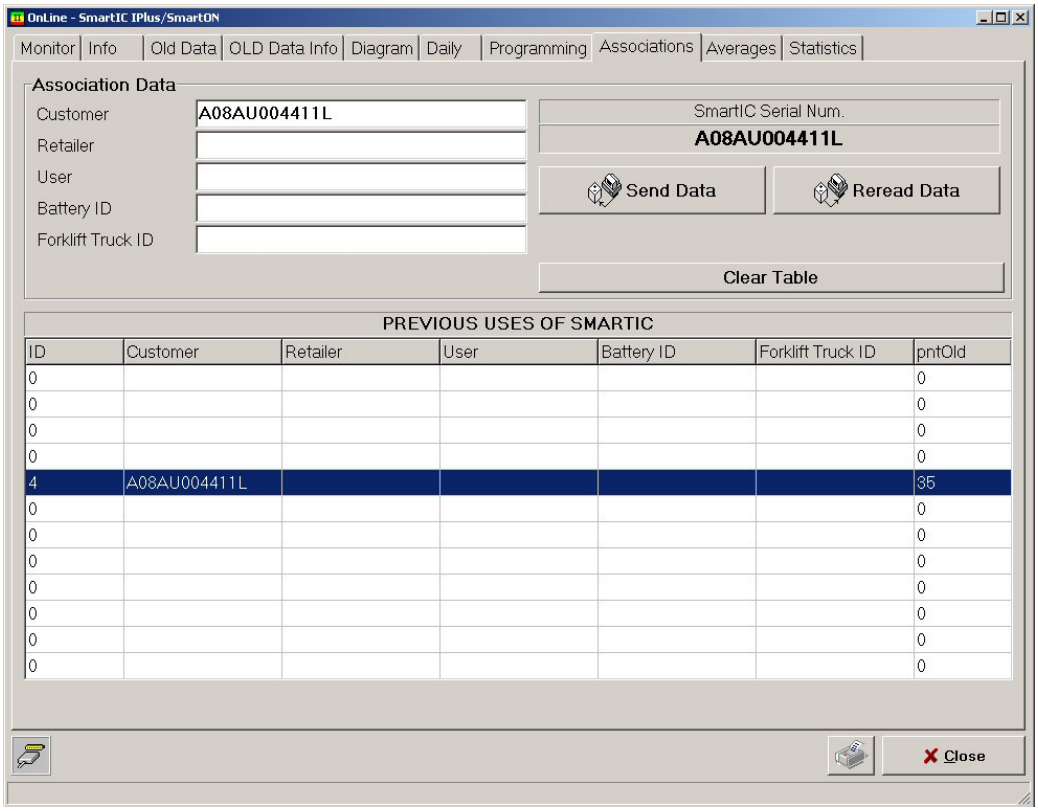


- Press the button "Send data to SmartIC" for the changes to take effect (for greater security check the operation by pressing the button "Read data from SmartIC" and verify that the parameters read are those entered)

NOTE: The work parameters can also be set in advance, before installing the device on the battery.

4.4 – Programming of associations

Associations are memory parameters which working cycles and diagrams, collected by Smart.ON during normal operation, refer to. Every time cycles and diagrams will be downloaded onto a PC, they will be identifiable and selectable thanks to the above mentioned parameters.
Therefore, these parameters too need to be compiled very carefully.
NOTE: filling in the association parameters is not binding. If you do it, choose carefully names and codes, avoiding to fill in the same parameters for different Smart.ON's.
For more details refer to the user manual of the SmartViewII program.



SmartViewII: programming of the associations

- Select the "Associations" TAB
- Fill in the following fields:

Customer	Text identifying customer
Retailer	Text identifying dealer
User	Text identifying user
Battery ID	Text identifying battery serial number
Forklift Truck ID	Text identifying forklift truck serial number

- Press the "Send data" pushbutton and check if a string with the parameters put in appears in the table underneath.

NOTE: The programming of the associations can also be executed in advance in the laboratory if all parameters are known.

5 – Alignment

To make SmartON fully operational and therefore collect and subsequently supply all the data, it must acquire the real state of the battery. This is called ALIGNMENT and must be performed only once after connecting the device to the battery. During normal operation, the SmartON device stays aligned by measuring and counting the inbound and outbound charge of the battery.
The alignment procedure involves the execution of a traditional full charge, that is:

- The battery voltage reaches the value indicated in the configured "Voltage Threshold 2nd Stage" parameter (default: 2.4V/el)
- The charge continues after reaching this voltage for a period not shorter than that established with the configured "2nd Stage Charging Time" parameter (default: 2 hours).

After the alignment procedure, all LEDs are lit in the Battery mimic panel, indicating that the battery is fully charged.
It is recommended that the alignment procedure be run with the battery not fully charged.

IMPORTANT: Normally, the alignment is very easy to execute. It is enough to recharge the battery with a conventional battery charger. Nonetheless, it is not always possible to recharge a battery in the aforementioned conditions. This may be due to various reasons, including:

- The battery is already charged and the battery charger performs a charge that is too short
- The battery voltage does not reach the "Voltage Threshold 2nd Stage" configured (this happens, for instance, for gel battery chargers)
- The battery charger has a particular kind of charging curve.

In these cases it is possible to change the "Voltage Threshold 2nd Stage" and/or "2nd Stage Charging Time" parameters by reducing their values to facilitate the achievement of the alignment. However, it is good practice not to deviate much from the default values to avoid providing the SmartON unit incorrect information about the real state of the battery.

NOTE: As long as the SmartON is misaligned:

- The red low battery LED flashes on the Mimic panel (unless the battery charge was forced using the procedure described in §2.7 – Use of the button (SmartON+ only).
- With SmartView:
    - In the Monitor TAB the battery charge status is replaced by the message "Ah Alignment not performed!!!"
    - In the OLD Data info TAB the graphic representation of the cycle is replaced by the message "Ah Alignment not performed!!!"
    - Elsewhere no battery charge reference values are displayed

Even when SmartON is not aligned all parameters measured during the cycle (voltages, currents, temperatures, date and time) and the graphs are logged.
NOTE: The alignment procedure must be repeated each time the SmartON is disconnected from the power supply.

6 – Specifications

Some useful technical information is reported below.

STORABLE GRAPH DATA:

Storable Working cycles	200
Storable graph data	4,800 samples (equal to 20 days with sampling every 6 minutes)
Storable daily data	The unit stores the work data of the previous 30 days

FIELD OF OPERATION:

Current cut-off switch 40A	batteries up to 170Ah
Current cut-off switch 80A	batteries from 180Ah to 345Ah
Current cut-off switch 160A	batteries from 350Ah to 740Ah
Current cut-off switch 320A	batteries from 745 to 1300Ah
Voltage cut-off switch L	batteries 24 - 48V
Voltage cut-off switch H	batteries 50 - 96V

ELECTRICAL/PHYSICAL SPECIFICATIONS

Power supply min/max	Size L: 18V - 72V Size H: 36V - 144V
Average power consumption	S-ON: 0.5W; S-ON+: 0.8W
Protection from internal breakdown	Fuse on the power input
Contact Relay (SmartON+ only)	1A @ 30Vdc (Vmax = 50Vdc/Vac)
Protection from external causes	Electronic components protected by H2SO4 resistant resin
Operating temperature	-20°C to +50°C